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Original communication

Derivation of the Genital Injury Severity Scale (GISS): A concise instrument for description and measurement of external female genital injury after sexual intercourse

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ABSTRACT

Introduction: Inconsistencies abound in the current forensic literature regarding the definition, and as a result, the significance of female genital injury after sexual intercourse. These definitions are based on variables related to the anatomic locations that are examined, the actual physical findings types, and the methods used to detect the findings.
Purpose: To derive and perform initial clinimetric analyses on a simple instrument that defines, and based on severity, quantifies external genital injury after sexual intercourse. The scale utilizes standard injury definitions and a standardized examination method.
Methods: After empirical investigation, it was determined that the application of the tool would require the use of magnification and toluidine blue in order to have the sensitivity to detect the majority of injuries that occur after sexual intercourse. Separate matrices were constructed based on anatomic locations and injury types from data collected from sexual assault genital injury examination forms. Principal Components Analyses were applied. A clinical model was constructed from the resultant variables, utilizing operational definitions and forming a template for the instrument.
Results: A twelve-factor instrument measuring five variables along five "types" of severity and two "classes" of severity ensued. The resultant instrument was tested for internal consistency and differential validity. Very good internal consistency was attained (Cronbach's Coefficient $\alpha = 0.8$). In a pilot study, the scale was able to distinguish a cohort of sexual assault patients from one of consensual intercourse subjects based on type and class of injury ($p < 0.0001$).
Conclusion: The findings presented demonstrate that while employing a standardized examination method, the Genital Injury Severity Scale has utility in defining and measuring external genital injury after sexual intercourse.

1. Introduction

Recent advances in forensic science have revolutionized the investigation and hence, the interpretation of evidence in the prosecution of sexual assault (SA) cases. In the past, prosecution relied on simple evidence such as presence of sperm or grossly-detected injury as corroboration of nonconsensual sexual contact. Today, DNA evidence is essential in identification cases, and in consent cases the interpretation of subtle patterns of genital injury is being argued on a regular basis.

Studies conducted in the past three decades looked at the prevalence of anogenital injuries (AGI) in adolescent and adult females after reported SA[1–17] as well as consensual intercourse

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(CI).[18–30] These studies (the lists are representative but not exhaustive) have generally demonstrated an increase in the detection of AGI when adjuncts such as magnification and/or toluidine blue (TB) dye were used during the examination. All of the observational studies that examined volunteer CI subjects used at least one form of adjunct and had AGI detection rates between 11% and 73%. Seven of these studies reported that the adjuncts were actually required to detect most findings.[20,23–25,27,29,30] The other CI studies did not specify whether the findings were detected with or without the use of magnification and/or TB. Case reports of more severe genital injuries after CI exist but are from cases where patients presented for medical care due to their injuries.[31,32]

The studies that used magnification and/or TB during the SA exam showed AGI detection rates ranging from 32% to 87%[2,5–9,12,14,15,18,21–26,28] compared to the studies that relied only on gross visualization, having injury detection rates between 6% and 69%.[1,3,4,9–11,13,16,17,33] The wide variations within each of the stated ranges are attributable to differing examination variables, inconsistent definitions of "findings", varying time intervals from sexual intercourse to exam, inclusion differences in age categories of the victims or subjects, and differing statistical analysis methods. These variations demonstrate the difficulty in interpreting any one group, much less any combination of them.

Fig. 1 demonstrates that the two groups: (1) those SA AGI that are only detectable using adjuncts, and (2) the CI adjunct-positive AGI, need further study in order to eventually determine which independent variables (assault condition-related, demographic, victim/assailant characteristic, etc) contribute to the probabilities that the examination findings are more consistent with those of a SA patient or a CI subject.

Despite the detection method, there remain a number of cases of CI *and* SA that have no AGI. The United States (US) Department of Justice reports on rape and SA victims who sought medical attention after their assault. The most recent report[34] cites that in the last decade, on average, 366,460 attempted or completed rapes and SAs were reported to law enforcement and/or seen in medical facilities annually. Of these, 91,410 (25%) incurred some sort of injury during the assault, and the majority (80,470 (22% of total)) of these injuries were considered minor. There was no breakdown of anatomical location of injury, nor any mention of methods used to detect injury in this report, but from this, we can deduce that at least 75% of victims of sexual assault in the US incur no major physical injury from their assault. This statistic, combined with those cited in the aforementioned studies on AGI after CI and SA, reinforce the concept that despite the detection method or definition of injury, there remain a significant number of cases after SA that remain uninjured or have only minor injuries. This group warrants etiologic study. In order to do that, there must be assurance that all potential findings have been detected.

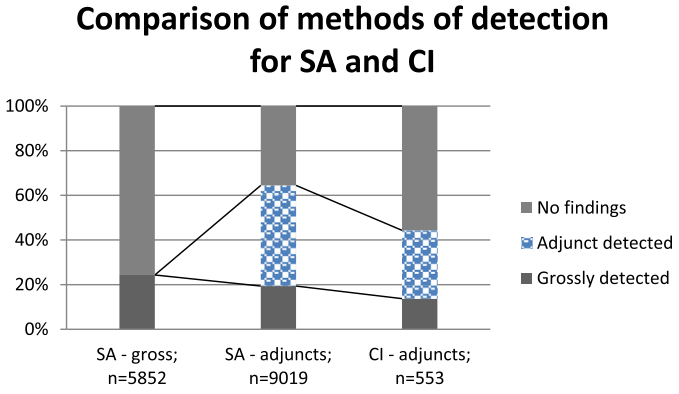

Fig. 1. Combined prevalence results of past 3 decades of SA/CI studies on physical findings (using all studies cited in the above paragraphs). Elimination of the adjunct-detected segments would result in SA and CI groups that would be difficult to compare.

In a court of law, it is not a cohort that is under scrutiny in a given case. It is the results of one examination. When the examination shows grossly detectable or severe AGI, the significance is less likely to be considered equivocal. Given the understanding that the majority of exam findings after sexual intercourse requires adjuncts for detection, the potential for making inferences about significance of a particular pattern of these minor findings contains three prerequisites: (1) these minor injuries need to be detected, (2) a standardization of measurement needs to be agreed-upon, and (3) SA groups need to be compared to CI groups. A number of authors have indicated the need for a severity scale and standardized taxonomy related to genital injuries incurred after sexual assault.[10,12,15,28,35–37] The authors have derived a scale for measuring genital injury that is based on severity and utilizes a standardized examination method having the sensitivity to detect the type of genital findings that allow comparison between SA and CI.[38]

1.1. Prior scales

Although a search of the relevant literature found no validated measurement scales for use in quantifying genital findings in an SA examination, there exists a vulvar injury scale for use in trauma surgery.[39] The GISS is not aiming to replicate this existing scale, as even the mildest score on the existing scale is more severe than the majority of injuries found after sexual assault and it is extremely rare for an injury that would fall within the range of the trauma scale to occur after CI. Other trauma severity scales include the Abbreviated Injury Scale[40] and the Injury Severity Score.[41] These scales' objectives are primarily for severe body trauma scoring and are used to predict hospital length of stay, residual disability and probability of surviving the trauma injury. The derivation of the GISS utilized similar clinimetric analyses as the current scales. Sexual assault forensic examiners currently rely on empiric methods to estimate the likelihood that examination findings are consistent with the history given by the victim. The examiner relies on his or her clinical experience and familiarity with the relevant research. A number of sexual assault forensic examiner (SAFE)/researchers have incorporated severity in some form in their research independent variables. McGregor, in her 1999[36] and 2002[35] studies on physical examination factors involved in prosecution and adjudication of sexual assault cases utilized a clinical injury score as an independent variable. It was a single score that encompassed both genital and nongenital injury. Palmer, in her study on genital injury of SA victims[10] retrospectively categorized the recorded injury findings, subjectively, as "mild, moderate, or severe" but no parameters for each category were stated in the study. Jones, in his study of adolescents after SA and CI,[21] incorporated severity in his results, however no definition of severity was given in his methods. Tintinalli[17] categorized injury types as "mild, moderate or severe". Sommers[37] is evaluating an injury classification for genital and nongenital injury after sexual and interpersonal violence.

Rules 702 and 703 of The US Federal Rules of Evidence stipulate that for methods to be considered valid in the examination of the SA victim, they should be scientifically tested, i.e. have a known rate of error, have established standards, and be subjected to peer review and scientific rigor.[42] Thus, a standardized and evidence-based[43] approach to the female sexual assault examination is necessary, and has medical and legal implications.

The majority of scales that exist in literature are in the social sciences and involve questionnaires where measurement of constructs is largely theoretical and abstract. In the case of this physical

exam inspection-based scale, there is a concrete basis for measurement of the individual physical exam variables. Measurement relies on the individual examiner's medical training and ability to discern the distinct visual findings. The authors' objective in the actual design of the scale is for it to be simple to apply and to yield valid results, regardless of the examiners' level of experience in performing SA forensic examinations.

2. Methods

2.1. Examination method

In order to test the scale for validity, comparison between SA and CI groups is crucial. Because of this, both magnification and toluidine blue are required when using the scale, as they are both required to detect the majority of genital findings after SA and CI.

2.1.1. Magnification

Colposcopes and most macroscopic/zoom lenses on cameras used in forensic examinations have the minimum magnification capability of 2.5 power. Quality colposcopes are known for having high resolution in addition to their magnifying power. Most colposcopes have the capability to have a camera attached and to obtain still or video images. The capability to document the magnified exam with images is certainly advantageous forensically and for utilization of the GISS, but these images never replace the higher resolution and ability to see subtle findings that are afforded by the examiners' contemporaneous visualization through the eyepiece or viewfinder. Colposcopy, when used for the SA forensic examination is determined to be an Evidence-Based Medicine Class II method.[43] The US Department of Justice[44] endorses the use of the colposcope in identifying recent genital and perineal injuries in sexual assault patients. Lenahan[9] found a significant increase in the detection of ecchymosis, abrasions and lacerations with the use of the colposcope over that of direct visualization. Sommers[29] and Zink[30] found similar injury prevalence with direct visualization versus colposcopy when comparing both techniques on the same subject in the same examination of women after CI. The referent exam method in the Zink study was TB and the combination of magnification after TB application was not studied. Norvell[27] reported that all of the positive findings in his CI sample required the aid of the colposcope for detection.

2.1.2. Toluidine blue dye with and without magnification

Toluidine blue is a nuclear staining dye that was originally used in gynecologic oncology for the detection of vulvar neoplastic lesions. The superficial vulvar skin cells are anucleic, so any retention of the dye that is visible after application and then removal would be of deeper structures. Early relevant studies that utilized TB were initially performed to verify the anecdotal hypothesis that in adult SA victims the posterior structures were injured with at least, if not more frequency than the introitus and vagina.[23–25] Their results, as well as the results of the Sommers[29] and Zink[30] studies, demonstrated increased detection of posterior structure tears and abrasions, but decreased ability to detect erythema and ecchymosis when using TB. Results of the Zink study showed that TB was actually required to detect tears within 24 h of CI in the external genitalia in nine of the 120 participants. The use of toluidine blue in the forensic sexual assault exam has been determined to be an Evidence-Based Medicine Class II adjunct[43] (the same class as colposcopy). It was the studies that utilized the colposcope alone and the combination of the colposcope *and* TB that showed that the posterior structures were the predominantly-injured external genital structures in the adult SA victim and were usually also included in the two most injured locations of adolescent or the combined adolescent/adult samples.[7,15,18,28]

There are various reasons cited by researchers based on local practice and available technologies for their decisions to use or not use adjuncts, mostly related to the cost of the colposcope and training issues related to the use of TB and the colposcope. With very little training and adequate post-training peer-review, health care professionals that routinely perform much more complicated medical procedures should be able to apply, adequately remove, and interpret findings demonstrated with TB. Possible false-positive TB findings have been reported that are attributed to interpreting inadequately-removed dye in photographs as a positive finding. Examiners who routinely utilize TB in their examinations anecdotally report that the distinction between dye uptake and excess dye in tissue folds can be made during the contemporaneous examination, where it may not be as clear in photographs. In most, if not all forensic examinations, the legally documented physical examination is determined not through photographs, but based on what the examiner inspected in real-time. The authors have chosen to use the combination of magnification and TB in their application of the GISS, as we have surmised that the most sensitive method of detecting *any* finding is required, as demonstrated in Fig. 2. The GISS is also intended to be documented contemporaneously with the exam, and not based on photographs.

3. The Genital Injury Severity Scale

3.1. Overview of item development

All multivariate statistical analyses were conducted with SAS 9.2 (Statistical Analysis Systems, Cary, NC). The GISS was developed in three stages. First, a pool of 24 items was generated from a review

Method	Authors/year of publication	Study keywords	Ages	PCI	% w/ pos findings	95% CI for SA	Injury types analyzed
Gross	Gray-Eurom K, Seaberg D, Wears R/2002	Prosecution/Correlation w/ evidence	12-77	?	25%		vag opening, sw, abr,
	Cartwright P, Moore R, Anderson J, et al./1986	Genital inj/implied consent	?	?	16%		tears & lacs to introitus
	Sugar N, Fine D, Eckert L/2004	**Physical inj/case series**	**>14**	**72**	**22%**	**0.19-0.25**	**Sw, Er, Ec, Ab, Te**
	Palmer C, McNulty A, D'Este C, et al./2004	Genital inj	>13	72	22%		Ab, Ec, Te
	Riggs N, Houry D, Long G, et al./2000	Analysis of 1076 cases	all	?	53%		
TB	Lauber A, Souma M/1982	Use of TB after traumatic int	"women"	48	CI 4.5% SA 46%		Te, bleeding
	McCauley J, Guzinski G, Welch R, et al./1987	TB in corrab of rape in adults	"all adults"	48	CI 10% SA 58%		Te
Colpo only	McGregor M, Le G, Marion S, Wiebe E/1999	Is physical inj assoc w/ laying of charges	10-69	?	24%		Er, Ec, Ab, Te, tend
	McGregor M, DuMont J, Myhr T/2002	Is evidence related to successful prosec	?	?	41.8%		Er, Ec, Ab, Te, tend
	Slaughter L, Brown C, Crowley S, et al./1997	**Patterns of genit inj**	**11-85**	**48**	**CI 11% SA *68%***	**0.63-0.74**	**Sw, Er, Ec, Ab, Te**
	Lenahan L, Ernst A, Johnson B/1998	Colpo in eval of SA Vic	>14	24	6% w/o colpo 53% w/ colpo		Ec, Ab, Te
Colpo & TB	**Jones J,Rossman L, Wynn B, et al./2003**	**Adult vs Adol; epidem and patterns of anogen inj**	**adol 13-17 adult >17**	**ave 12.3**	adol 83% adult 64% **(all ages *72%*)**	**0.69-0.75**	**Sw, Er, Ec, Ab, Te**
	Anderson S, McClain N, Riviello R/2006	Genit findings after SA and CI	SA 16-54 CI adults	48	CI 30.4% SA 32.1%		Ec, Ab, Te
	Read K, Kufera J, Jackson C, et al./2005	Pop based stud	>12	?	33%		Er, Ec, Ab, Te, petechae
	Slaughter L, Brown C/1992	Colpo to est physical findings after SA	13-85	48	87%		Sw, Er, Ab, Te
	Sachs C, Chu L/2002	Predictors of genitorectal inj	"menstruating age"	72	81%		Ec, Ab, Te

Sw - swelling Er - erythema (redness) Ec - ecchymosis (bruising) Ab - abrasions Te - tears (lacerations) tend - tenderness PCI - post-coital interval

Fig. 2. Studies reporting proportion of anogenital injury after SA and based on detection method. Studies using like injury types in bold with 95% confidence intervals for injury proportions calculated by this papers' authors. Colposcope and toluidine blue use proportions far exceed gross detection proportions.

of the relevant literature, consultation with experts, and from the anogenital portion of the California Cal EMA 923[45] acute adult/adolescent sexual assault reporting form. Second, standard item reduction methods were used to eliminate items that did not apply directly to the examination of the female genitalia. Multivariate analyses were performed on the remaining variables to determine which contributed the most to the variability when looking at an independent sample of sexual assault forensic examinations performed at the authors' emergency department. Third, the scale was evaluated for internal consistency and empirical differential validity.[46]

Institutional Review Board approval was granted by the hospital and the academic institution where the authors are employed. Consent for anonymous usage of data is part of the consent provided by all patients who receive a forensic examination at the hospital.

3.1.1. Stage 1: Item generation

A pool of potential scale items was generated based on review of the existing literature of physical findings detected in a sexual assault examination, the standardized sexual assault physical findings reporting form for the state of California[45]; after a thorough review of cases in the institutional database; after consultation with experts in the field; and through the authors' empiric knowledge of the subject. The scale's authors are emergency medicine midlevel practitioners (physician assistants/nurse practitioners). They possess a minimum of 10 years of experience performing sexual assault forensic examinations as well as genital examinations of non-assaulted patients, in an urban emergency department in the US. The initial item pool consisted of 24 injury type and anatomic structure combinations, shown in Fig. 3.

3.1.2. Stage 2: Standard item reduction

Any variable that was not considered to be part of the genitalia was reduced as the determination was made that the scale would only consider the genitalia. Additionally, based on the fact that the majority of findings of the genitalia after sexual intercourse are to the external structures, the scale would only evaluate external locations. This determination maximized the possibility that the scale would be useful in comparing SA with CI. Since tenderness is a very subjective finding, it was reduced as a variable. The resulting GISS would only consider visible finding types.

Principal Components Analyses (PCA) were performed using the remaining variables. The PCA were executed in two separate stages, to account for the separate variable types that remained (findings types and anatomical locations). There were 14 remaining variables after the first two stages of item generation/reduction. An independent sample of 318 sexual assault examinations performed at the emergency department where the authors are employed was used in the PCA . PCA was chosen as the multivariate analysis in this case because the components are tangible, visible physical examination variables and not questionnaire items that lend to latent concepts that would indicate a Factor Analysis. Each principal component (PC) is an exact linear combination of the original variables.[47]

Data for the PCAs were encoded from the genital findings section of the CalEMA 923 form into two Microsoft Excel worksheets. The first PCA model (PCA-1) included the seven anatomical locations from the Stage 2 reduced item list of 14. For each observation ($n = 318$), each anatomic location that remained after the second stage item reduction (labia minora, clitoris, periurethra, perihymen/vestibule, hymen, fossa navicularis, and posterior fourchette) was numerically coded to represent the finding type that was found by the original examiner. The values represented an ordinal scale ranging from 0 for no findings to 5 for lacerations or transection. The variances of these variables in the correlation matrix ranged from 0.09659 to 4.01012. Given the wide range of the lowest to the highest variance, the covariance matrix was utilized for this PCA as shown in Table 1.

The second PCA version (PCA-2) modeled the variables that described the types of findings seen in the external genitalia examination. The worksheet was encoded with the findings types that remained after the stage 2 item reduction (none, nonspecific, swelling, erythema, ecchymosis, abrasion, laceration/transection) capturing the number of each findings type per observation.

The Eigenvectors table [Table 2], which reveals the first five PCs, shows that the first PC contains approximate equal loadings of the findings types commonly referred to with the *TEARS* acronym (tears (lacerations), ecchymosis, abrasions, redness (erythema), and swelling).[28] The nonspecific findings loaded heavily on the second PC, the more severe type of diffuse findings (abrasion and ecchymosis) loaded heavily on the third PC, findings that relied on color change (erythema and ecchymosis) loaded heavily on the fourth PC, and abrasions loaded heavily on the fifth PC but were already captured by the third PC.

The authors' goal was to utilize the separate types of variables (anatomical location and findings types) retained by the item generation/reduction stages, as well as keep a parsimonious model that lends to the logical determination of severity as the basic measurement method. In order to do this, the findings types encompass the individual rows. The resultant clinical model construct is displayed in Fig. 4. The columns represent the continuum of severity levels called "types". These range from no findings to the most severe of each of the individual variables. The operational definitions of the cells on the less severe (left) side of the layout are those that are more commonly found in timely examinations of women after consensual intercourse, and the authors have labeled these Class A findings. Conversely, the cell definitions on the more severe side (right) in the layout are more commonly described after sexual assault (labeled Class B).

Injury types:	Findings/injury to:
• Swelling of any structure*	• Buttocks
• Erythema of any structure*	• Perianal skin
• Ecchymosis of any structure*	• Anal verge/folds/rugae
• Abrasion of any structure*	• Rectum
• Tear or transection of any structure*	• Vaginal walls
• No findings to a structure*	• Cervix
• Nonspecific findings*	• Inner thighs
• Tenderness to any structure	• Perineum
	• Labia majora
	• Labia minora*
	• Clitoris/surrounding area*
	• Periurethral tissue/urethral meatus*
	• Perihymenal tissue (vestibule)*
	• Hymen*
	• Fossa navicularis*
	• Posterior fourchette*

Fig. 3. Initially-generated item pool, considering all potential scale variables. Items denoted with * indicate the variables that remained after standard item reduction method.

Table 1
SAS output showing Eigenvectors in Princomp procedure for PCA-1.[a]

Eigenvectors					
	Prin1	Prin2	Prin3	Prin4	Prin5
LabMin	0.192433	0.790899	−0.237543	0.516938	−0.075935
Clitoris	0.024176	0.036743	−0.034518	0.065509	−0.029142
PeriUreth	0.007355	0.021007	−0.023841	0.034633	−0.020519
PeriHym	0.126407	0.519397	0.275776	−0.749648	−0.274175
Hymen	0.064963	0.210887	0.087057	−0.159410	0.957484
FN	0.119333	0.002225	0.920117	0.371656	−0.030666
PF	0.963271	−0.241737	−0.107545	−0.042095	−0.008737

[a] The clitoris and periurethral locations do not contribute any information to the analysis, therefore were reduced from the model.

Table 2
SAS output for Princomp procedure for PCA-2 (Eigenvectors for findings types).

Eigenvectors					
	Prin1	Prin2	Prin3	Prin4	Prin5
NoneOther	−0.709303	−0.053745	0.031292	−0.074867	−0.010959
Nonspecific	0.073526	0.734641	−0.090779	0.293277	0.166370
Swelling	0.358085	0.287567	−0.367672	−0.401889	0.341612
Erythema	0.335205	−0.362417	−0.466812	0.559856	−0.269526
Ecchymosis	0.155619	0.314948	0.603845	0.368368	−0.283224
Abrasions	0.277884	−0.376875	0.461417	0.110845	0.670818
Lac_Transec	0.386600	−0.046329	0.245255	−0.534274	−0.502639

3.1.3. Stage 3: Scale evaluation

3.1.3.1. Internal consistency and differential validity testing. After PCA, the internal consistency of each item within a component was determined.[46] A *Cronbach's* α of 0.8 was obtained on standardized variables demonstrating very good internal consistency.[38] The data analyzed for this test were GISS Types and individual GISS variable Types for consecutive sexual assault examinations performed at the authors' emergency department. The data were collected over a one and a half year time frame for which the examiner prospectively completed a GISS ($n = 262$). If the standardized alpha increases after removing a variable from the construct, then removing this variable from the scale makes the construct more reliable. There was no significant increase in the standardized alpha after stepwise deletion of each variable in the GISS.

Differential (empirical) validity was tested in a pilot study[22] which compared a cohort of CI volunteers with one of adult women after SA. The GISS was successful in distinguishing the two cohorts, when both GISS Type and GISS Class were the resultant variables. Furthermore, the authors' hypothesis that SA findings are more severe than CI findings was also substantiated. Table 3 reports the statistical results from the pilot study.

3.2. Determining the GISS Type and Class

An examiner completes the GISS prospectively, during the external genital examination with utilization of magnification and TB dye. The appropriate severity (column) of each individual finding (row) is selected based on the results of the examination.

Genital Injury Severity Scale (GISS)

	Type 1	Type 2	Type 3	Type 4	Type 5
Swelling	(-) (0)	+ Mild (1)	++ Significant (2)		
Color Change (erythema to contusion)	(-) (0)	+ Pink/Red (1)	++ Significant Redness (2)	Purple (3)	
Tissue Break (tear to abrasion)	(-) (0)	Superficial: seen only with colpo and/or TB (1)	Mild: linear tears into epidermis visible with eye (2)	Moderate: deeper and wider into dermis (3)	Severe: tear into the subcutaneous or deeper (4)
Hymen and Introitus	(-) (0)		Incomplete tear/s (2)	Complete transection (3)	Complete transection and disruption into introitus (4)
Toluidine Blue dye uptake	(-) (0)	-/+ Flat/punctate uptake (1)	+ Specific uptake (2)		
	Tissue integrity intact Class A		Tissue integrity disrupted Class B		

Fig. 4. The Genital Injury Severity Scale (GISS), developed by the authors (2006) showing the initially-derived version of the GISS. This version contained individual cell scores (numbers in parentheses) that summed to a GISS Index. The index calculation method is currently under revision.

The examiner identifies the cell most representative of the most severe observed finding for each category. Operational definitions for each severity level are provided by the clinical model cells. GISS Type 1 means that there are no findings in the variable; Type 2 represents that nonspecific findings are present but are in the range that is less commonly found after SA; Type 3 contains the findings that are the least severe of the types that are more commonly found after SA; Type 5 represents the most severe of each variable; and Type 4 is for those findings that would fall between Type 3 and Type 5. The overall GISS Type is determined based on the individual finding representing the most severe injury (the right-most chosen column). So, even if multiple findings are in the least injured Type, the Type value is based on the single most severe finding. Types 1 and 2 constitute Class A (less likely found after SA) and Types 3, 4, and 5 are considered Class B (more likely found after SA).

4. Discussion

We sought to develop an examiner-administered Genital Injury Severity Scale to be used contemporaneously during the examination of the adult or adolescent female presenting after consensual or nonconsensual sexual intercourse. Our main objective was to derive a scale that is simple to apply by examiners with various levels of experience. Pilot testing of this GISS showed the ability of the scale to distinguish a cohort of CI subjects from one of SA victims based on the GISS Type and Class score.[22] In our pilot study, examiners were able to complete the GISS in less than 30 s, and after some experience, in under 15 s. The scale results in ordinal values for five of the most representative genital examination variables, as well as an ordinal composite value that summarizes the most severe findings from that examination. These values were shown by Principal Components Analyses and Internal Consistency testing to capture the most information about the external genital examination in the least number of variables.

4.1. Potential clinical applications

In the clinical setting, the numerical ordinal result that it yields can be used in follow-up of SA cases to measure healing rates and resolution of injury.

4.2. Potential research applications

With its standardized examination method and operational definitions of the various levels of severity across each examination variable's continuum, the GISS can potentially be the initiation of a common language for researchers when reporting genital examination results of SA studies. In utilizing the examination methods that are the most sensitive in detecting the large portion of injuries sustained after SA and CI, the GISS allows a level playing field for comparing these two cohorts in future studies. The Type and Class values can become outcome variables for future studies with an endless potential of input variables (SA versus CI, age groups, assault related, demographic related, etc). These values can also be utilized as dependent variables in meta-analyses, something that has until now, been difficult in SA literature.

4.3. Potential justice system applications

The GISS in its current form does not have criminal justice utility, as neither type nor class can identify with certainty a SA patient. It can only be used to determine if CI and SA cohorts can be confirmed in a population sample. Based on even the current sensitive methods of detecting genital injury, it is known that there are still a significant number of patients after SA examinations that

Table 3
Statistical results of authors' pilot study[22] (differential validity analysis).

	Type 1	Type 2	Type 3	Type 4	Type 5	
Consensual Intercourse N=50 Median 2, Minimum 1, Maximum 4	No findings 21 (42%)	ANY findings 29 (58%)				ChiSq: 0.368 df=1 p=.**544**
	Type 1 21 (42%)	Type 2 24 (48%)	Type 3 4 (8%)	Type 4 1 (2%)	Type 5 0	
	Types 1,2 No injury 45 (90%)		Types 3,4,5 Injury[1] 5 (10%)			ChiSq: 15.875 df=1 p**<0.0001**
Sig diff medians, p<0.0001 [2]	**Class A**		**Class B**			
Sexual Assault N=185 Median 2, Minimum 1, Maximum 4	Types 1,2 No injury 111 (60%)		Types 3,4,5 Injury[1] 74 (40%)			
	Type 1 69 (37%)	Type 2 42 (23%)	Type 3 57 (31%)	Type 4 17 (9%)	Type 5 0	
	No findings 69 (37%)	ANY findings 116 (63%)				
	Type 1	**Type 2**	**Type 3**	**Type 4**	**Type 5**	

[1]Per authors' definitions, "injury" only found with types 3,4,5 (Class B)
[2]Per Independent Samples Median test

have no detectable injury. By the same token, there also exists a number of women after recent CI that have detectable findings. Taking the balance of probabilities into account, if the GISS tests valid, it has the potential to be used in conjunction with the other facts of individual cases to assist the legal process. Scores from a GISS could be compared between SA cases with and without verdicts to determine if significant differences occur.

5. Limitations

One of the conditions the authors cited that is required before inferences can be made about a particular pattern of genital injury is the comparison of cohorts of CI and SA cases. In order to use a severity index as a dependent variable to test for differences between these cohorts, there needs to be strict criteria to define the cohorts.

When studies actually recruit CI subjects, there is little doubt that the intercourse was truly consensual. Controversy however, surrounds the definition of a sexual assault case. The major inclusion criterion of a gold standard for SA is a case that has been prosecuted to a guilty verdict. The exclusion criteria for this definition eliminates the vast majority of those cases that receive a SA forensic examination, therefore severely skews the sampling frame. This skewness virtually eliminates those actual sexual assault cases for whom a suspect is never identified, those where the victim did not cooperate in the prosecution, did not report the incident, and those cases that were not prosecuted based on obsolete precedent of requiring a degree of physical injury and/or presence of sperm. In the US, determining a gold standard GISS for SA will be difficult based on the above factors, in addition to the fact that cases can take years to be prosecuted and that there is no real-time investigative database of SA cases as are present in other countries.

The GISS' use is limited to the contemporaneous examination of the external genitalia of the adolescent and adult female. Male genital injury and ano-rectal injury on either gender, while warranting further study after SA, do not apply to the GISS.

In order to detect the majority of genital findings after CI or SA, adjuncts are needed, so utilization of both magnification and TB are required for use of the scale. Centers that do not use both of these adjuncts will not be able to utilize the GISS as it is designed.

6. Conclusions

Researchers have repeatedly indicated a need for a Genital Injury Severity Scale in the area of sexual assault forensic medicine. The ideal scale could initially provide a common language for reporting results of research in the area of sexual assault forensic examinations. This scale, if validated and eventually adopted, will replace the current nomenclature of "findings absent" or "findings present" with numerical, analyzable values assigned to operational definitions. Reliability testing utilizing examiners with various experience and training levels, and validity testing on varying demographic populations needs to occur before the GISS can be applied clinically or forensically. Although a scale could never answer the question of guilt or innocence of a person accused of committing a crime, it could contribute to the balance of probabilities when looking at an individual case.

Conferences and lectures

This work was introduced at the International Association of Forensic Nurses "Scientific Assembly": November 2006, Vancouver, BC, Canada; presented at the Clinical Forensic Medical Institute/Child Abuse Network Conference: September 2006–2009, University of California, Davis, and presented at the California Clinical Medical Forensic Training Center's Annual Spring Training workshop in Shell Beach, CA March 2013.

Submission declaration

This work has not previously been published. The differential validity analysis was published in the form of a pilot study in 2012, and is properly cited in the text and bibliography of this paper. This

pilot study paper received the Journal of Forensic Nursing's Research Article of the Year (2012) Award. This paper is not submitted to any other source.

Ethical approval

None sought.

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Grant support was provided for the differential validity study, which was published earlier this year (one of the biometrics that was performed for the development of the scale). No funding was provided for the remaining aspects of the scale development. All work was performed during the authors' own time or to a limited extent, during the normal course of employment in the emergency department and the university. None of the authors has any financial interest in any aspect of the scale (including companies that manufacture or distribute colposcopes, digital cameras, or toluidine blue dye).

Contribution of authors

Dana Kelly coded all of the data, performed all of the statistical analyses, modified the clinical model, co-presented during lectures about the scale, and penned the manuscript.

Hillary Larkin was instrumental in the original scale concept, was a primary contributor to the clinical model, was primary presenter in lectures about the scale, and edited and approved the manuscript.

Cecily Cosby originally conceptualized the scale, was instrumental in developing the clinical model, co-presenter of lectures/poster about the scale, and approved the manuscript.

Lauri Paolinetti was instrumental in the original conceptualization of the scale, was a primary contributor to the clinical model, was co-presenter of lectures/poster about the scale, and approved the manuscript.

Conflict of interest

The authors hereby declare that they have no conflict of interest.

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